FIG. 1

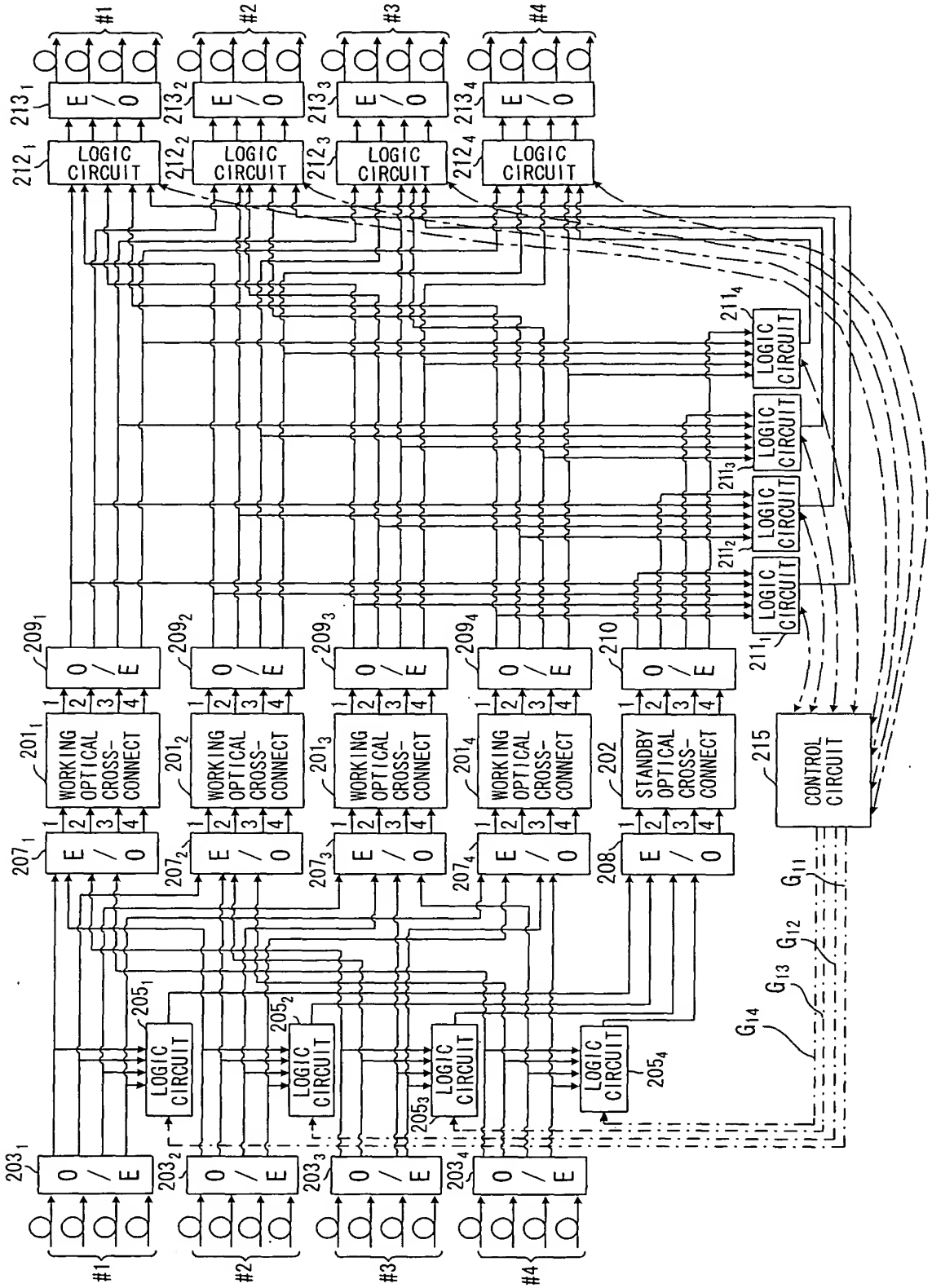

#1
#2
#3
#4
LOGIC CIRCUIT
WORKING OPTICAL CROSS-CONNECT
STANDBY OPTICAL CROSS-CONNECT
CONTROL CIRCUIT
O/E
E/O
G11
G12
G13
G14

FIG. 2

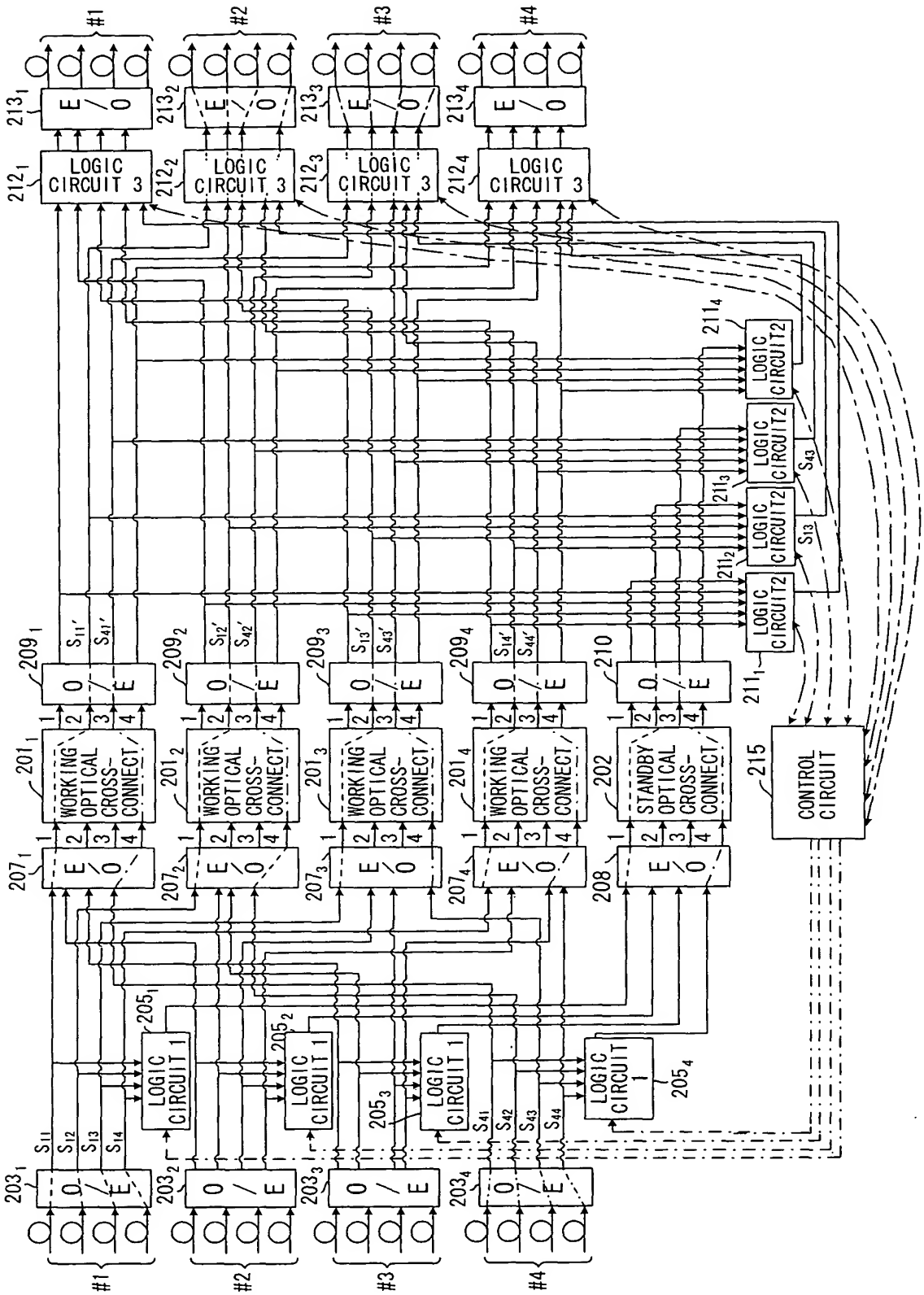

#1
#2
#3
#4
LOGIC CIRCUIT 3
WORKING OPTICAL CROSS-CONNECT
STANDBY OPTICAL CROSS-CONNECT
LOGIC CIRCUIT 1
LOGIC CIRCUIT2
CONTROL CIRCUIT
O/E
E/O

FIG. 3

(a) WHEN OPERATION IS NORMAL

	NUMBER OF "1"s ON ith CHANNEL	OUTPUT OF LOGIC CIRCUIT 205_i	NUMBER OF jth OUTPUTS OF ALL CROSS-CONNECTS THAT ARE "1"s	OUTPUT OF LOGIC CIRCUIT 211_j
①	ODD	"1"	ODD	"0"
②	EVEN	"0"	EVEN	"0"

(b) WHEN MALFUNCTION OCCURS

	NUMBER OF "1"s ON ith CHANNEL	OUTPUT OF LOGIC CIRCUIT 205_i	NUMBER OF jth OUTPUTS OF ALL CROSS-CONNECTS THAT ARE "1"s	OUTPUT OF LOGIC CIRCUIT 211_j
③	ODD	"1"	ODD	"0"
④	EVEN	"0"	EVEN	"0"

FIG. 4

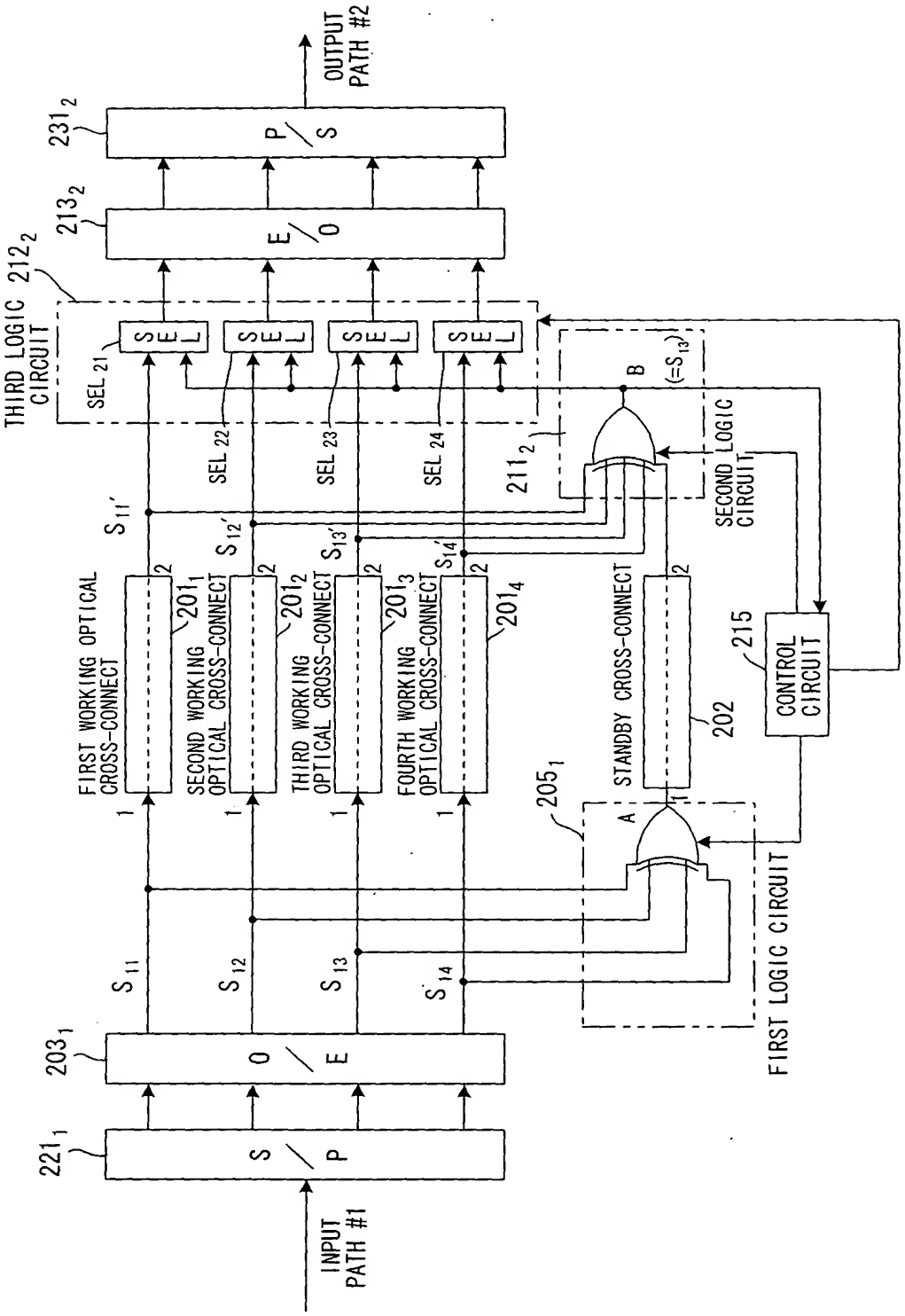

INPUT PATH #1
OUTPUT PATH #2
FIRST LOGIC CIRCUIT
SECOND LOGIC CIRCUIT
THIRD LOGIC CIRCUIT
FIRST WORKING OPTICAL CROSS-CONNECT
SECOND WORKING OPTICAL CROSS-CONNECT
THIRD WORKING OPTICAL CROSS-CONNECT
FOURTH WORKING OPTICAL CROSS-CONNECT
STANDBY CROSS-CONNECT
CONTROL CIRCUIT
SEL
S/P
P/S
E/O
O/E
A
B
(=S13')

FIG. 5

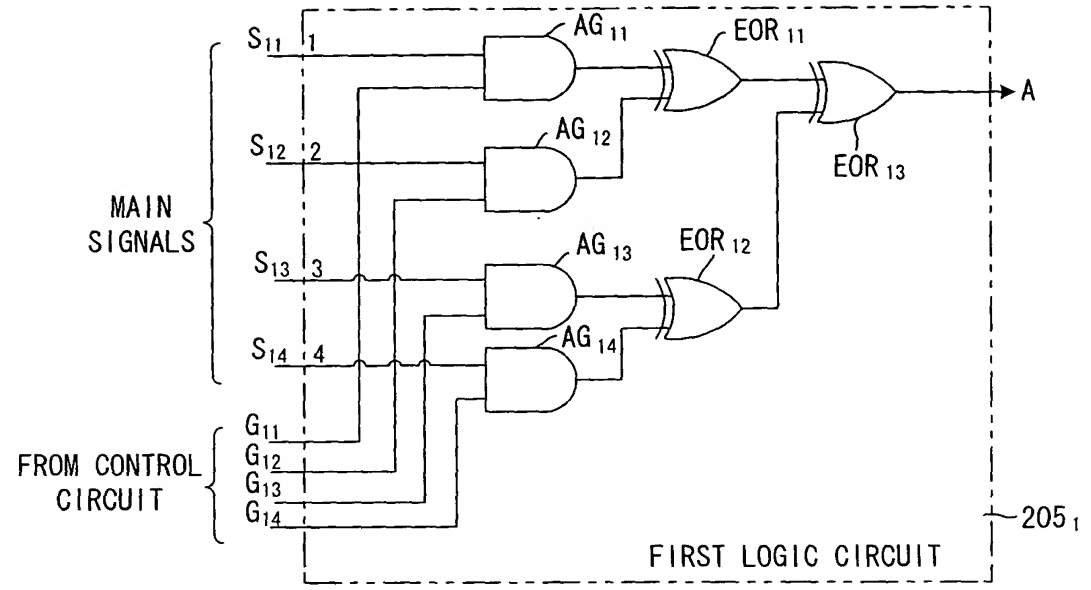

MAIN SIGNALS
S11 1
S12 2
S13 3
S14 4
FROM CONTROL CIRCUIT
G11
G12
G13
G14
AG 11
AG 12
AG 13
AG 14
EOR 11
EOR 12
EOR 13
A
FIRST LOGIC CIRCUIT
205 1

FIG. 6

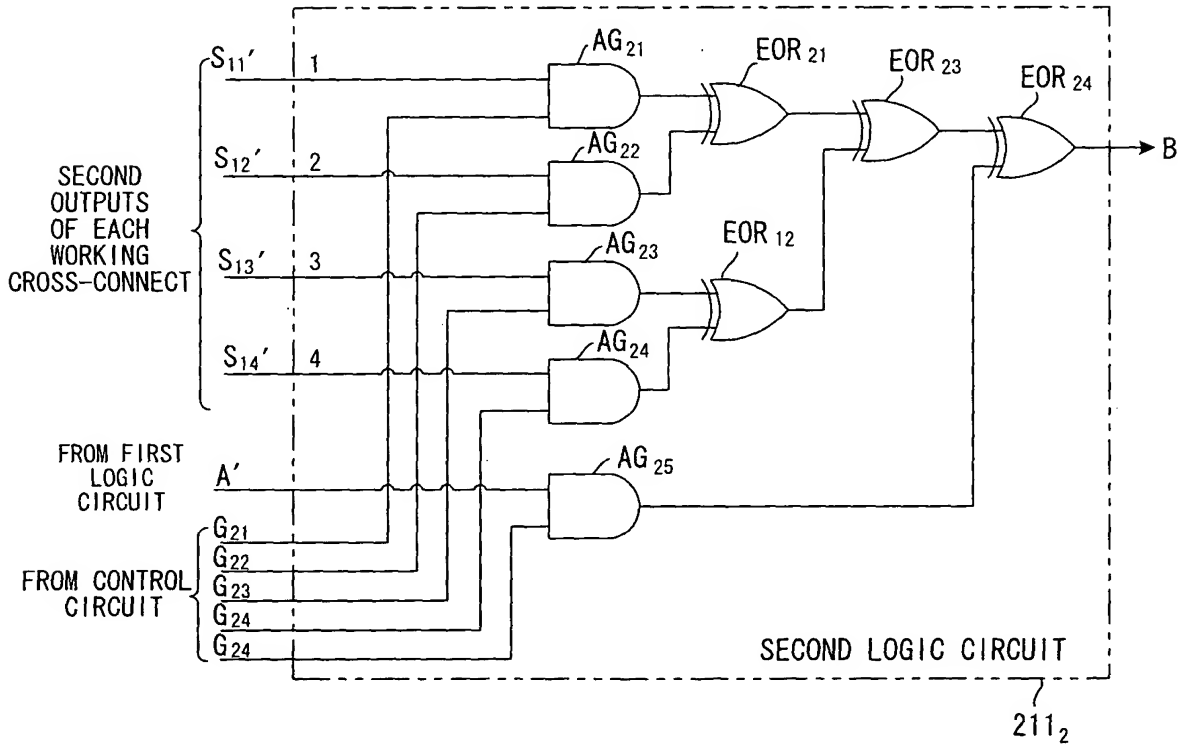

SECOND OUTPUTS OF EACH WORKING CROSS-CONNECT
S11′ 1
S12′ 2
S13′ 3
S14′ 4
FROM FIRST LOGIC CIRCUIT
A′
FROM CONTROL CIRCUIT
G21
G22
G23
G24
G24
AG21
AG22
AG23
AG24
AG 25
EOR 21
EOR 23
EOR 24
EOR 12
B
SECOND LOGIC CIRCUIT
211 2

FIG. 7

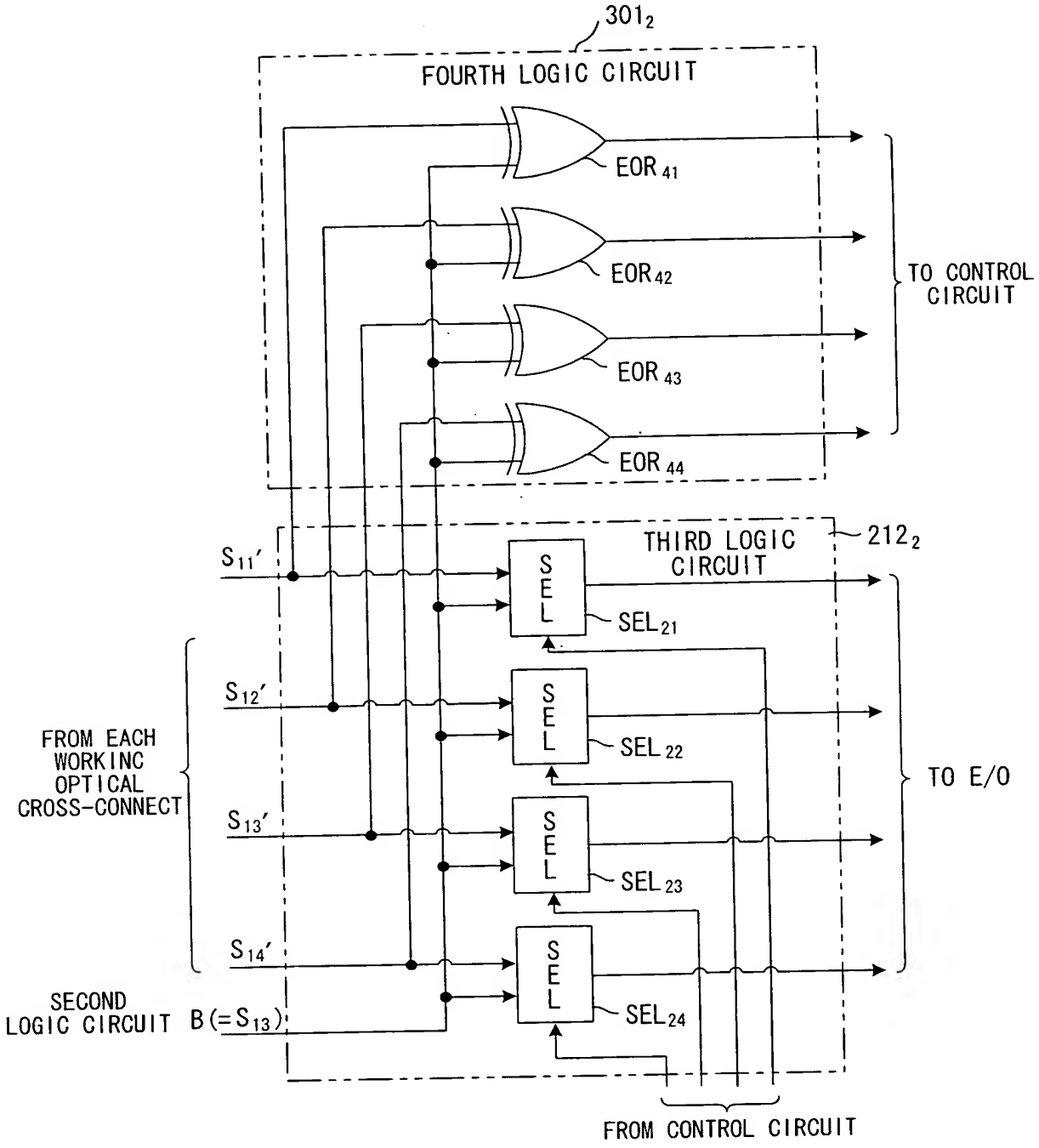

301_2
FOURTH LOGIC CIRCUIT
EOR_{41}
EOR_{42}
EOR_{43}
EOR_{44}
TO CONTROL CIRCUIT
THIRD LOGIC CIRCUIT
212_2
S_{11}'
S_{12}'
S_{13}'
S_{14}'
SEL
SEL_{21}
SEL_{22}
SEL_{23}
SEL_{24}
FROM EACH WORKING OPTICAL CROSS-CONNECT
SECOND LOGIC CIRCUIT
$B(=S_{13})$
TO E/O
FROM CONTROL CIRCUIT

FIG. 8

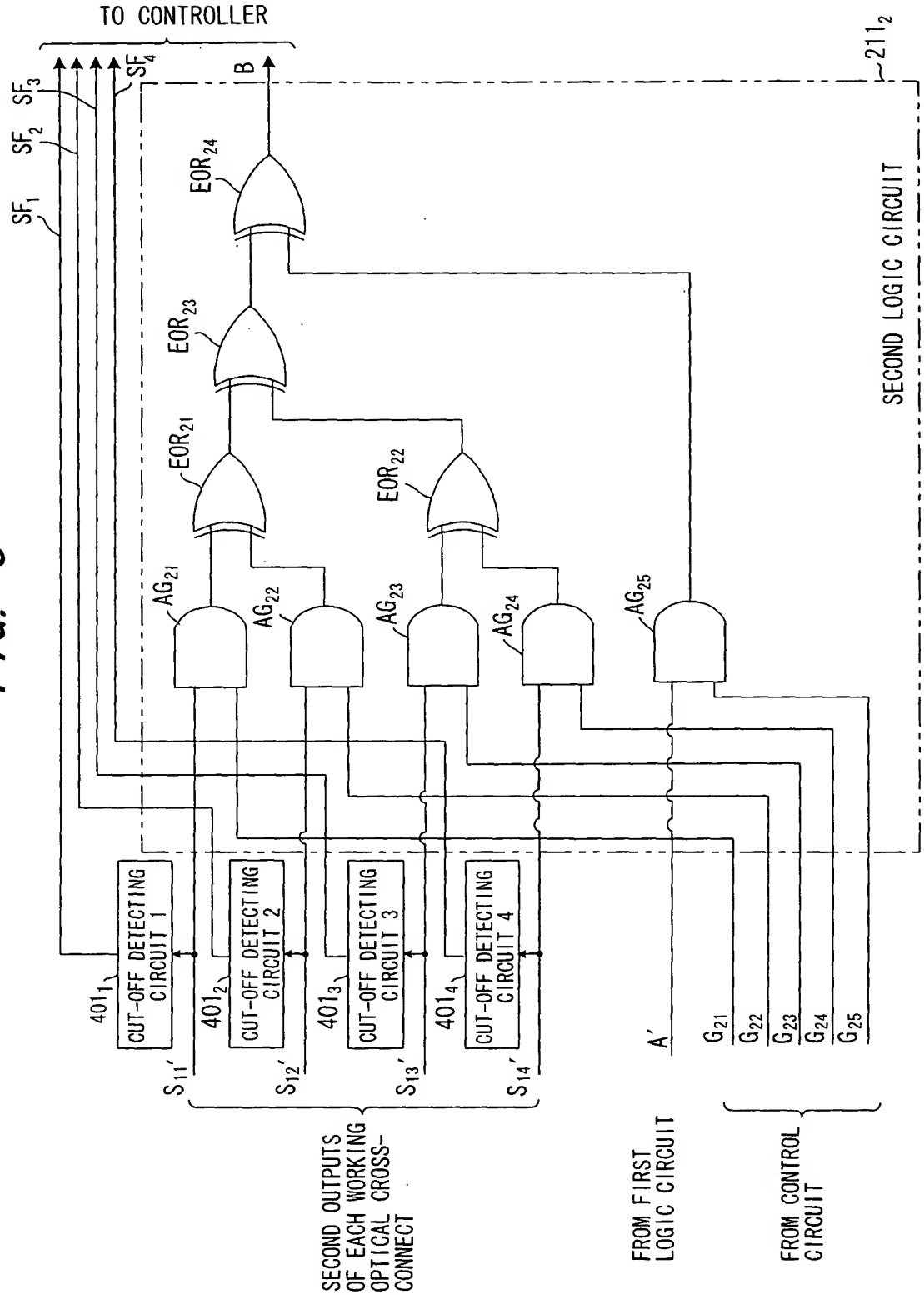

TO CONTROLLER
SF1
SF2
SF3
SF4
B
2112
SECOND LOGIC CIRCUIT
EOR24
EOR23
EOR21
EOR22
AG21
AG22
AG23
AG24
AG25
4011
CUT-OFF DETECTING CIRCUIT 1
4012
CUT-OFF DETECTING CIRCUIT 2
4013
CUT-OFF DETECTING CIRCUIT 3
4014
CUT-OFF DETECTING CIRCUIT 4
S11'
S12'
S13'
S14'
SECOND OUTPUTS OF EACH WORKING OPTICAL CROSS-CONNECT
A'
FROM FIRST LOGIC CIRCUIT
G21
G22
G23
G24
G25
FROM CONTROL CIRCUIT

FIG. 9

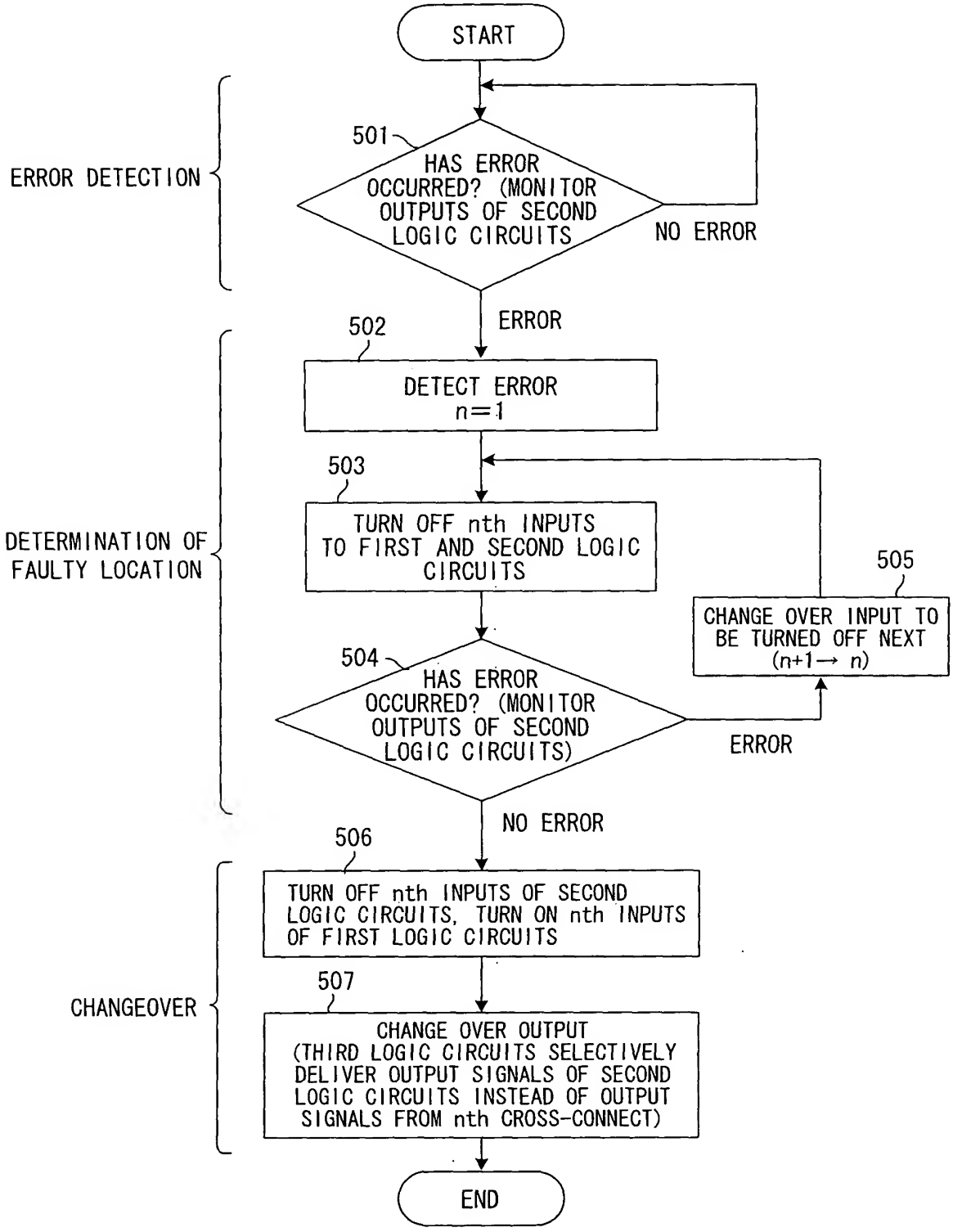

START
ERROR DETECTION
501
HAS ERROR OCCURRED? (MONITOR OUTPUTS OF SECOND LOGIC CIRCUITS
NO ERROR
ERROR
502
DETECT ERROR
n=1
DETERMINATION OF FAULTY LOCATION
503
TURN OFF nth INPUTS TO FIRST AND SECOND LOGIC CIRCUITS
505
CHANGE OVER INPUT TO BE TURNED OFF NEXT (n+1→ n)
504
HAS ERROR OCCURRED? (MONITOR OUTPUTS OF SECOND LOGIC CIRCUITS)
ERROR
NO ERROR
506
TURN OFF nth INPUTS OF SECOND LOGIC CIRCUITS, TURN ON nth INPUTS OF FIRST LOGIC CIRCUITS
507
CHANGEOVER
CHANGE OVER OUTPUT (THIRD LOGIC CIRCUITS SELECTIVELY DELIVER OUTPUT SIGNALS OF SECOND LOGIC CIRCUITS INSTEAD OF OUTPUT SIGNALS FROM nth CROSS-CONNECT)
END

FIG. 10

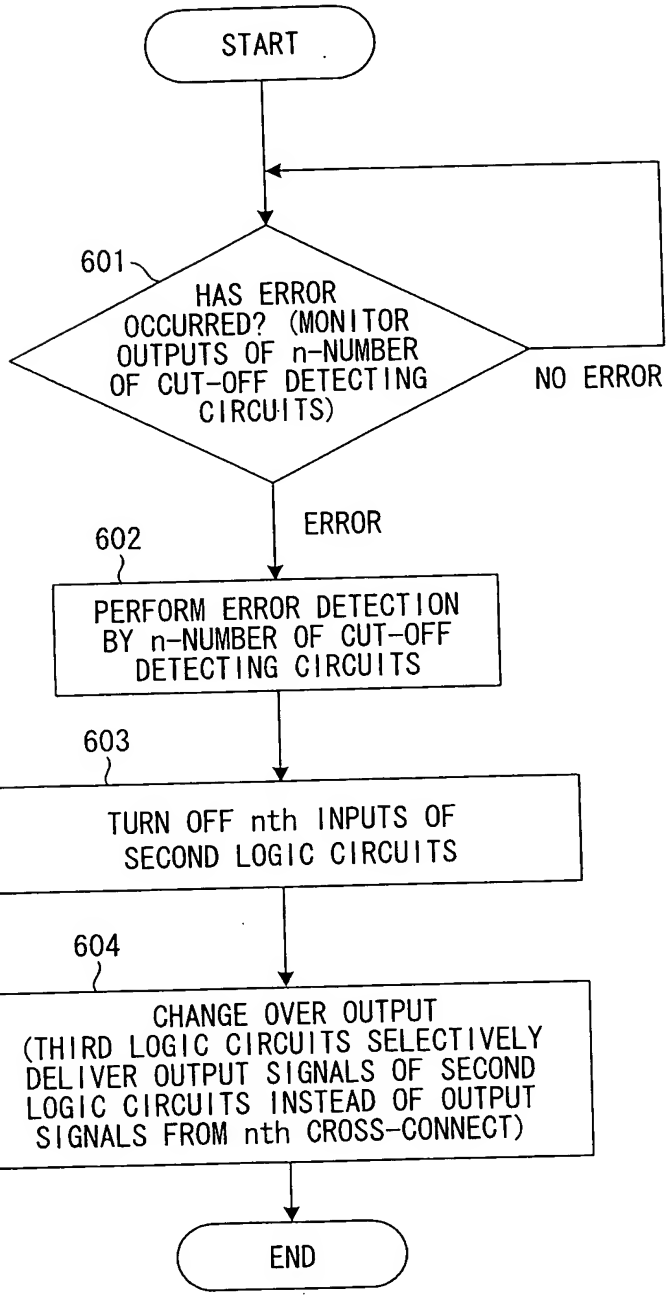

START
601
HAS ERROR OCCURRED? (MONITOR OUTPUTS OF n-NUMBER OF CUT-OFF DETECTING CIRCUITS)
NO ERROR
ERROR
602
PERFORM ERROR DETECTION BY n-NUMBER OF CUT-OFF DETECTING CIRCUITS
603
TURN OFF nth INPUTS OF SECOND LOGIC CIRCUITS
604
CHANGE OVER OUTPUT (THIRD LOGIC CIRCUITS SELECTIVELY DELIVER OUTPUT SIGNALS OF SECOND LOGIC CIRCUITS INSTEAD OF OUTPUT SIGNALS FROM nth CROSS-CONNECT)
END

FIG. 11

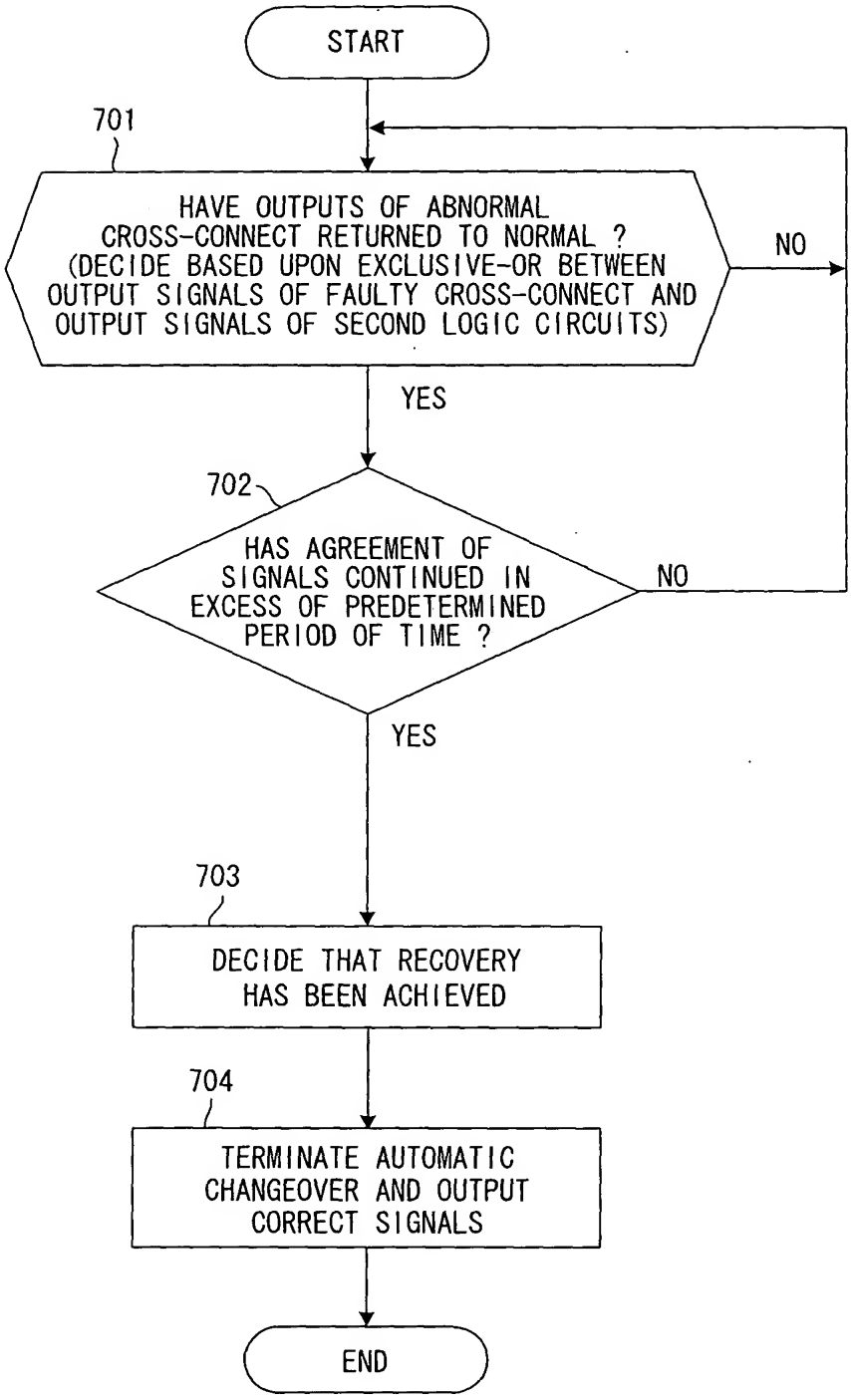

START
701
HAVE OUTPUTS OF ABNORMAL CROSS-CONNECT RETURNED TO NORMAL ? (DECIDE BASED UPON EXCLUSIVE-OR BETWEEN OUTPUT SIGNALS OF FAULTY CROSS-CONNECT AND OUTPUT SIGNALS OF SECOND LOGIC CIRCUITS)
NO
YES
702
HAS AGREEMENT OF SIGNALS CONTINUED IN EXCESS OF PREDETERMINED PERIOD OF TIME ?
NO
YES
703
DECIDE THAT RECOVERY HAS BEEN ACHIEVED
704
TERMINATE AUTOMATIC CHANGEOVER AND OUTPUT CORRECT SIGNALS
END

FIG. 12

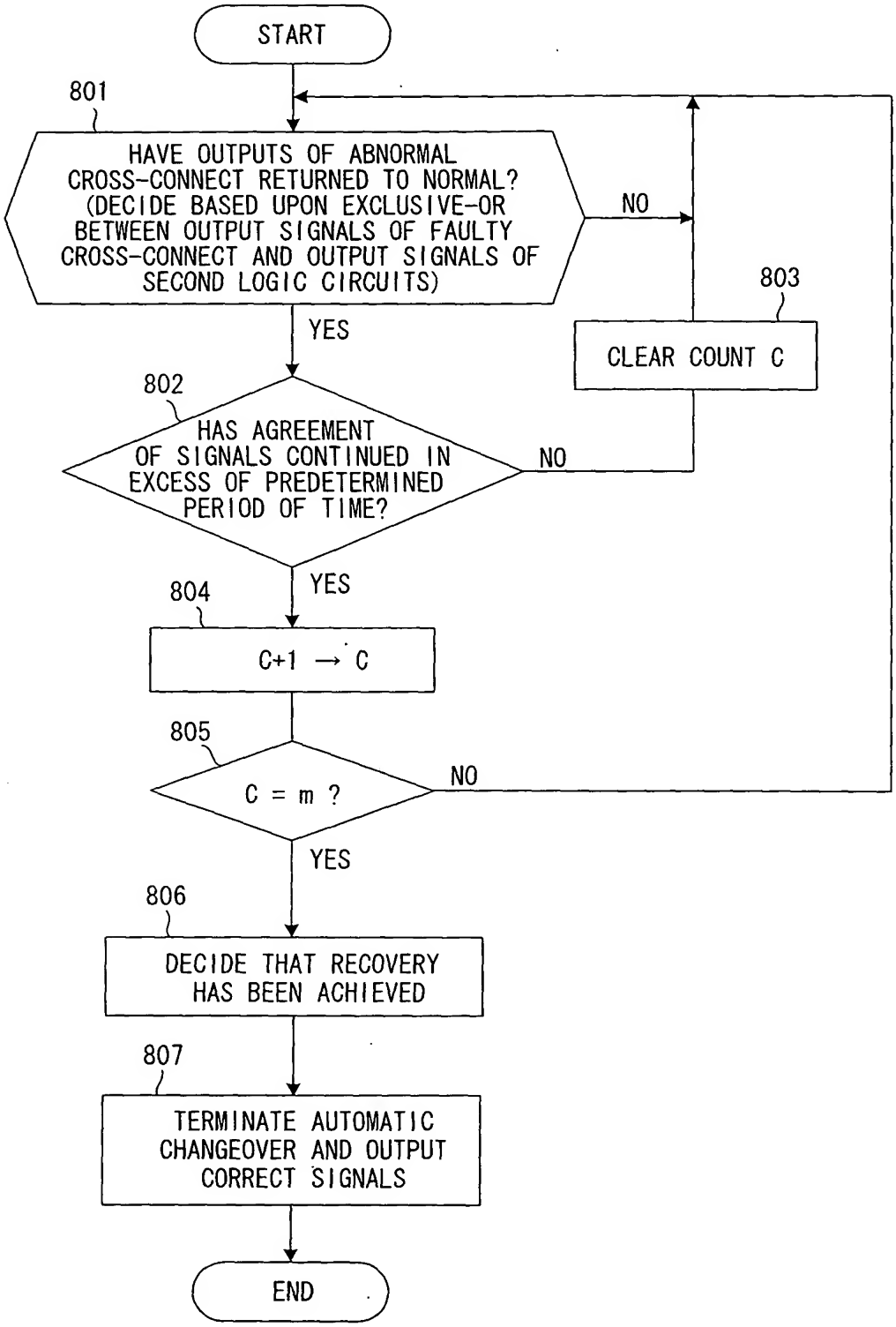

START
801
HAVE OUTPUTS OF ABNORMAL CROSS-CONNECT RETURNED TO NORMAL? (DECIDE BASED UPON EXCLUSIVE-OR BETWEEN OUTPUT SIGNALS OF FAULTY CROSS-CONNECT AND OUTPUT SIGNALS OF SECOND LOGIC CIRCUITS)
NO
803
CLEAR COUNT C
YES
802
HAS AGREEMENT OF SIGNALS CONTINUED IN EXCESS OF PREDETERMINED PERIOD OF TIME?
NO
YES
804
C+1 → C
805
C = m ?
NO
YES
806
DECIDE THAT RECOVERY HAS BEEN ACHIEVED
807
TERMINATE AUTOMATIC CHANGEOVER AND OUTPUT CORRECT SIGNALS
END

FIG. 13

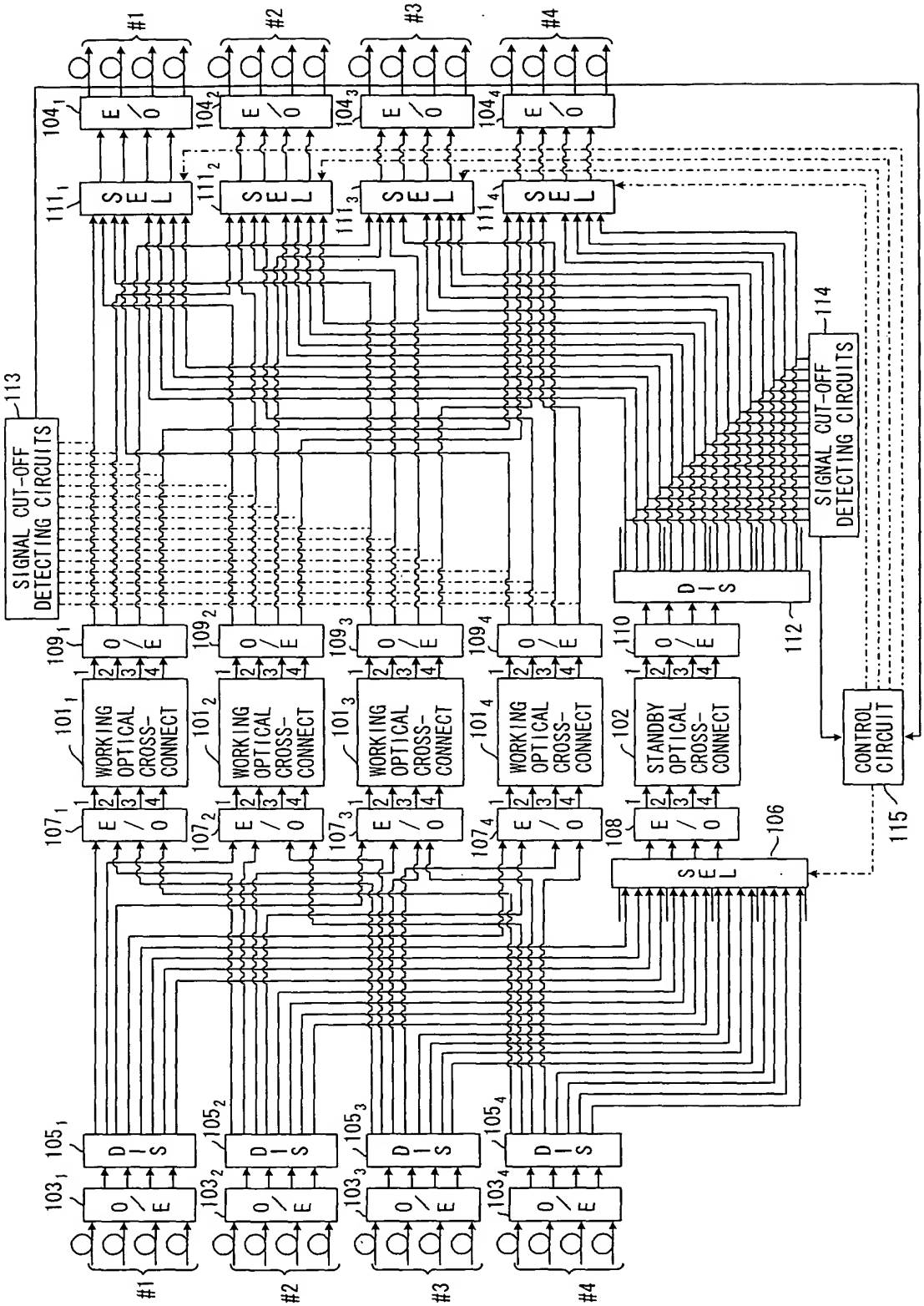

#1
#2
#3
#4
SIGNAL CUT-OFF DETECTING CIRCUITS
SIGNAL CUT-OFF DETECTING CIRCUITS
WORKING OPTICAL CROSS-CONNECT
WORKING OPTICAL CROSS-CONNECT
WORKING OPTICAL CROSS-CONNECT
WORKING OPTICAL CROSS-CONNECT
STANDBY OPTICAL CROSS-CONNECT
CONTROL CIRCUIT
SEL
DIS
O/E
E/O

FIG. 14

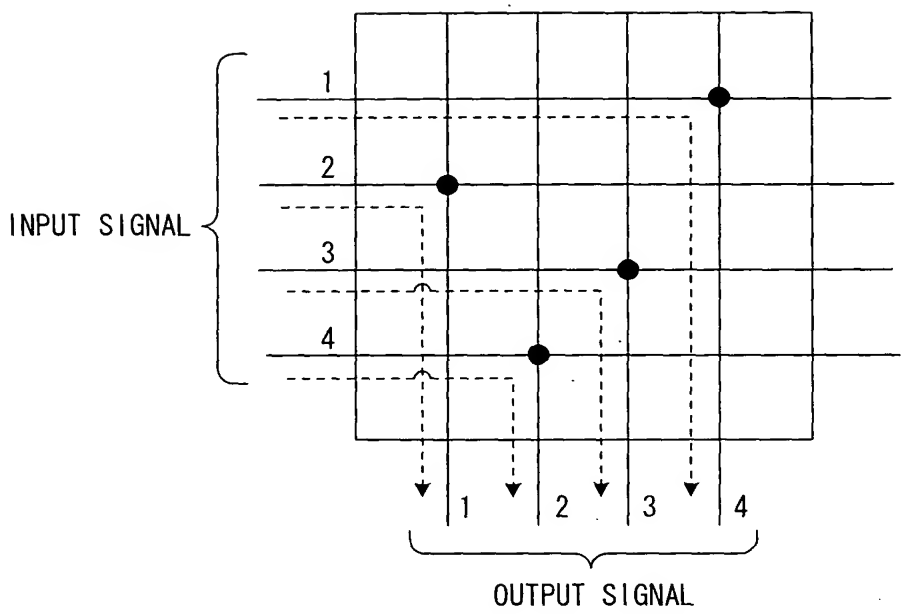
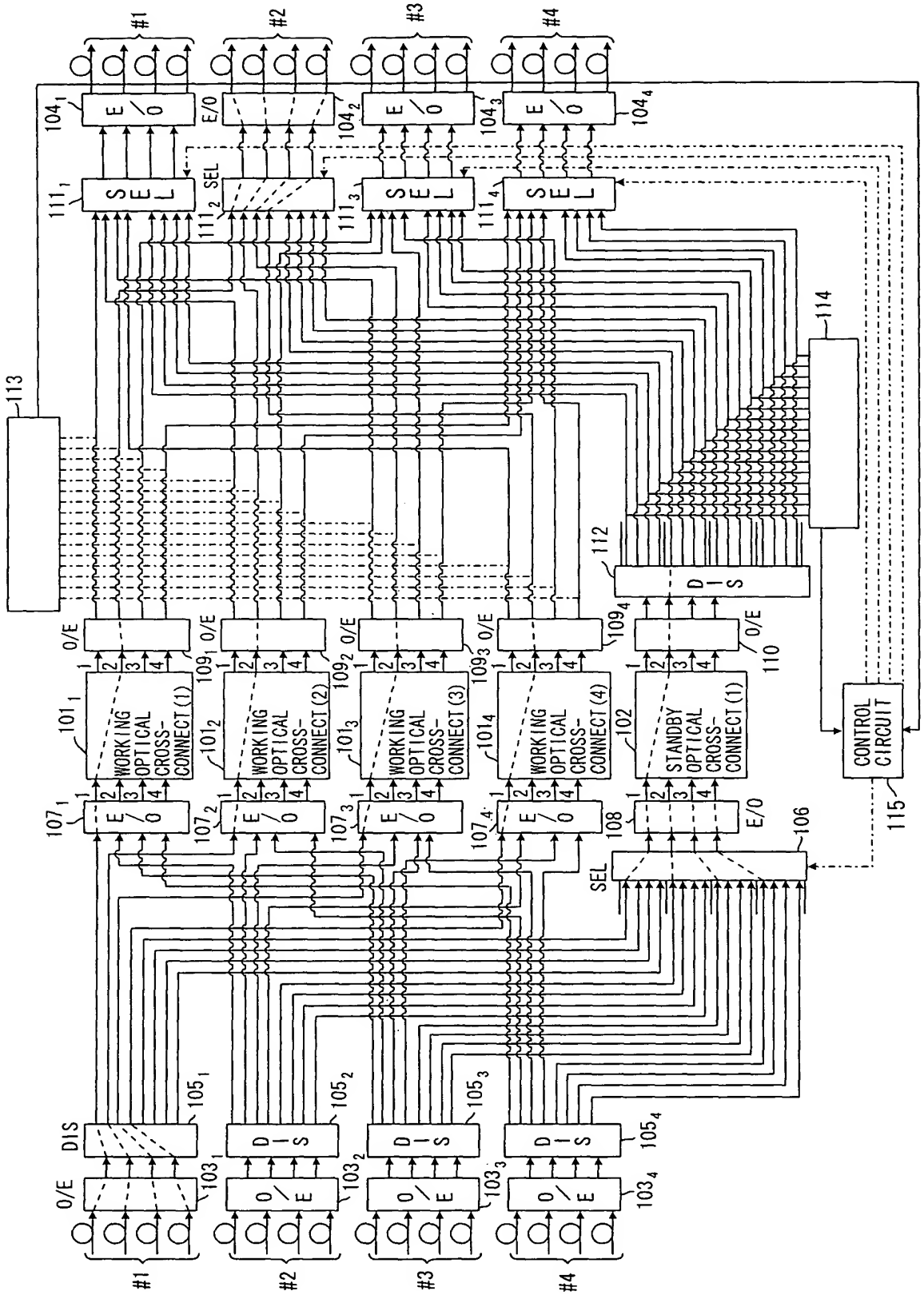


FIG. 15


#1
#2
#3
#4
O/E
DIS
SEL
E/O
WORKING OPTICAL CROSS-CONNECT (1)
WORKING OPTICAL CROSS-CONNECT (2)
WORKING OPTICAL CROSS-CONNECT (3)
WORKING OPTICAL CROSS-CONNECT (4)
STANDBY OPTICAL CROSS-CONNECT (1)
CONTROL CIRCUIT
113
114
115
106
108
102
110
112
101 1
101 2
101 3
101 4
103 1
103 2
103 3
103 4
104 1
104 2
104 3
104 4
105 1
105 2
105 3
105 4
107 1
107 2
107 3
107 4
109 1
109 2
109 3
109 4
111 1
111 2
111 3
111 4